AX-16-000-2275

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
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JUN 30 2016

REPLY TO THE ATTENTION OF:

WQ-16J

Mr. Christopher L. Rissetto
Center for Regulatory Reasonableness
1620 I Street, N.W.
Suite 701
Washington, D.C. 20006

Dear Mr. Rissetto:

This responds to your December 10, 2015, letter on behalf of the Center for Regulatory Reasonableness (CRR Letter), in which you request that the U.S. Environmental Protection Agency withdraw its January 23, 2015, approval of the State of Minnesota's eutrophication criteria for rivers and streams. For the reasons described below, EPA denies your request.

## I. Background

### A. EPA's Approval of Minnesota's Eutrophication Criteria

On January 23, 2015, EPA approved Minnesota's eutrophication standards for rivers and streams, after concluding that those criteria are based on sound scientific rationale and protective of Minnesota's aquatic life use designations. Section IV.A of the January 23, 2015, document entitled "Basis for EPA Approval of Minnesota's New or Revised Eutrophication and Total Suspended Solids Criteria in Accordance with Section 303(c) of the Clean Water Act" (January 23, 2015, Decision Document) sets forth the bases for EPA's conclusion. On pages 7-8 of that document, EPA explained that the Minnesota Pollution Control Agency (MPCA):

> followed a process consistent with the four-step process set forth in EPA's Stressor-response Guidance to derive its eutrophication criteria for protection of aquatic life designated uses for rivers and streams. MPCA first developed a conceptual model to describe the way that increasing concentrations of nutrients (*i.e.*, eutrophication) affect aquatic ecosystems. MPCA identified chlorophyll *a*, diel DO flux, $BOD_5$, and diel maximum pH as indicators of primary producer community and ecosystem response, based on the conceptual model. MPCA determined that, in Minnesota, TP correlates with these indicators and confirmed that increasing concentrations of phosphorus generally impact aquatic ecosystems in a manner consistent with its conceptual eutrophication model. With the exception of pH, which is already included in Minnesota's approved WQS as a criterion protective of aquatic life uses, MPCA then analyzed the relationship

of each of the eutrophication indicators to selected measures of biological community health using quantile regression and changepoint analysis. This analysis identified statistically significant thresholds based on changes in direct biological measures of aquatic life use support. MPCA analyzed the data and relationships in a regional context. These preliminary biologically-based thresholds were then compared to concentrations measured in minimally-disturbed reference sites in Minnesota, values drawn from the relevant scientific literature, and values derived through simple linear and serial regression analyses. Final criteria values were set at levels to protect aquatic life uses and prevent significant degradation from expected conditions.

EPA explained in detail on pages 8-35 of the January 23, 2015, Decision Document how MPCA performed each step in the process and the basis for EPA's conclusion that there was a sound scientific rationale for the criteria and that the criteria are protective of Minnesota's aquatic life use designations. Unless otherwise specified, the statements in this letter are based upon and supported by the January 23, 2015, Decision Document and information contained in documents that are part of the administrative record that EPA considered when it reviewed and approved Minnesota's eutrophication criteria. A list of documents that EPA considered when it reviewed and approved Minnesota's eutrophication criteria is enclosed with this letter.

## B. Summary of Minnesota's Development of Eutrophication Criteria

### 1. Stressor-response approach to deriving nutrient criteria

There is widespread scientific support that excessive nutrients, including phosphorus, can adversely impact aquatic life. However, water quality criteria for nutrients are unlike water quality criteria commonly adopted for pollutants that are directly toxic to aquatic organisms. Criteria for pollutants that are directly toxic are based on data generated by exposing test organisms to a known series of concentrations of the pollutant in a laboratory environment and determining the concentration that causes a toxic response within specified periods of time.

Unlike pollutants that are directly toxic, nutrients impact aquatic organisms indirectly. Just like when phosphate fertilizer is applied to a farm field to increase growth of desirable plants, addition of excess nutrients to aquatic systems causes increased growth of aquatic algae and plants and changes in the species that are present. The impact of these changes then cascades through the entire community of organisms, including:

- Modifications of aquatic food webs as a result of changes in the plant and algae community, leading to changes in the organisms that feed on the plants and algae and the organisms that feed on those organisms;
- As algal biomass increases, increased magnitude of daily fluctuations in dissolved oxygen as a result of oxygen-consuming respiration of algal cells during the night due to respiration and increased production of oxygen during the day due to photosynthesis;
- Oxygen levels less than those necessary to support aquatic organisms when large numbers of the increased mass of algal cells die and decay, resulting in conditions that are toxic to aquatic life; and

- Violations of pH criteria, resulting in potentially toxic conditions due to the increased consumption of $CO_2$ during photosynthesis and the release of $CO_2$ as a result of cellular respiration of elevated populations of algal cells.

Consistent with this indirect mode of action of nutrient pollution, adverse effects start with the presence of excess nutrients that lead to changes and increases in the plant and algal community, which in turn lead to changes in the fish and invertebrate community.

As a result of the indirect manner in which excess nutrients cause adverse effects on aquatic life, the approach used for deriving criteria for toxic pollutants (measuring the exposure that directly causes an adverse impact on exposed aquatic organisms in a laboratory and expressing the criteria as a pollutant concentration magnitude and duration) does not work for nutrients. In addition, other site-specific factors unrelated to nutrients, such as limited light due to shading or non-algal turbidity, limited available habitat, and high and low flow events, can influence the degree to which nutrients that are present in the water column are taken up by different organisms and alter the biological community at a particular site.

As explained in EPA's January 23, 2015, Decision Document, Minnesota's eutrophication standards were derived consistent with EPA's 2010 guidance document entitled "Using Stressor-response Relationships to Derive Numeric Nutrient Criteria." The stressor-response approach allows a state or tribe to establish criteria that are based on relationships between nutrient pollution and adverse biological responses based on empirical data. In this way, criteria can be tailored to protect the waters of a state or tribe based on observed relationships between nutrients and biological responses.

Minnesota's criteria are expressed as "combined criteria," meaning the criteria include numeric thresholds for both the stressor (in this case, total phosphorus) and the indicators of biological condition, or response (in Minnesota's case, chlorophyll *a,* diel dissolved oxygen flux, $BOD_5$, and pH) that must *both* (total phosphorus and at least one response indicator) be exceeded for the criteria to be considered not attained. The combined criteria approach addresses the facts that nutrients (including phosphorus) at high enough concentrations in water bodies can indirectly cause adverse impacts to aquatic life for the reasons described above and that, due to the types of site-specific factors described above, the extent to which high nutrient concentrations impact aquatic life may vary on a water-body-by-water body basis. The combined criteria approach is to develop a two-part combined criteria, consisting of "stressor" and "response" components that, as is the case with all water quality criteria, establish the level of water quality sufficient to protect the uses of the water (see CWA 303(c)(2)(A), 40 CFR 131.11(a)). The stressor component is the particular nutrient (phosphorus or nitrogen) that, at high enough concentrations, can adversely impact aquatic life. The response component is a parameter or parameters that can be used to monitor whether the high concentrations of the particular nutrient at issue are in fact resulting in a biological response in a particular water body to such an extent that the cascading effect described above would likely occur. If a particular, site-specific characteristic of a water body such as shading or high turbidity, make the particular water body insensitive to elevated levels of nutrients without a corresponding adverse biological response, then this will be reflected in the response component of the combined criteria not being exceeded, which in turn will mean that the water body will not be deemed to be nutrient-impaired, notwithstanding high nutrient concentrations, provided downstream uses will also be protected. The combined criteria approach, in requiring that both components of the combined criteria be exceeded for a water to be deemed exceeding the water quality standard, combined with the empirically-derived stressor-response relationships that are the basis for the thresholds for total phosphorus and the response indicators, accounts for many of the site-specific factors that might otherwise be of concern (identified in the CRR letter as "confounding factors").

The 2010 Stressor-response Guidance recommends an approach for determining the appropriate numeric thresholds that should be used in developing numeric nutrient criteria. This process includes assembling water quality monitoring data in a number of water bodies to determine the nutrient levels in those water bodies; assembling biological monitoring data (*e.g.*, monitoring of the numbers and diversity of primary producers or macroinvertebrates that exist in the water body, or other measurements of ecosystem function, such as pH or DO) that can be used to assess the health of aquatic life in the water bodies being studied; and conducting statistical analyses to estimate the relationships between adverse impacts to aquatic life and high nutrient levels. Then, further statistical analyses are performed to determine the specific thresholds that should be used to ensure aquatic life uses are protected, and those thresholds in turn comprise the numeric nutrient criteria.

### 2. Minnesota's Eutrophication Standards

As described in the January 23, 2015, Decision Document, the standards adopted by MPCA take the form of "combined criteria," which means that the criteria are comprised of threshold values for the nutrient parameter (TP), as well as threshold values for indicators of ecosystem response to nutrient pollution (chlorophyll *a*, $BOD_5$, daily fluctuations in dissolved oxygen called "diel DO flux," and pH). A site is considered exceeding the water quality standard when both the threshold value for TP and at least one of the indicator threshold values are exceeded. The methods used by MPCA to determine the relationships that are the basis of the threshold values that comprise Minnesota's combined criteria are consistent with the approach described in the 2010 Stressor-response Guidance.

MPCA selected $BOD_5$ as one indicator of nutrient pollution as part of its combined criteria. As phosphorus pollution increases, algal biomass increases and $BOD_5$ increases with increasing algal biomass because algal biomass is also decomposable organic matter. As MPCA stated in its *Statement of Need and Reasonableness*:

> BOD5 is an important measure of the potential stress on a biological community as there is a well-documented relationship between BOD5 and biological condition. There is a strong relationship between sestonic chlorophyll and BOD5 presumably due in part to the increase in organic matter available to heterotrophs because of algal death and algal respiration. Mallin *et al.* (2006; Exhibit EU-40) acknowledge a highly significant relationship among sestonic Chl-a and BOD5 and note that BOD5 can be increased in some waterbodies by direct stimulation of heterotrophic microbial flora by anthropogenic nutrient loading. The increase in BOD5 can lead to lower DO levels and greater diel DO flux and may indicate a shift in the food resources in the system. These responses lead to declines in biological condition and data from Minnesota indicates that there is a strong

response of biological metrics to increases in the BOD5. Many biological metrics indicated a negative shift in biological condition at ~2-3 mg/L BOD5 (Exhibit EU-1).

Diel dissolved oxygen flux is a measure of the magnitude of the difference between the lowest and highest dissolved oxygen concentrations in a surface water over a 24-hour period. Diel dissolved oxygen flux increases when algal biomass increases because the excess algae further increase dissolved oxygen concentrations in the water during the day as a result of photosynthesis and further depress oxygen concentrations in the water due to cellular respiration during the night when they cannot photosynthesize.

As described in Sections IV.A.3.b – IV.A.3.d of the January 23, 2015, Decision Document, MPCA based its combined criteria on extensive water quality monitoring data on TP and each of the threshold indicators of nutrient uptake for water bodies throughout Minnesota; extensive biomonitoring data (data on numbers of different types of fish and invertebrates) for those water bodies; and multiple statistical analyses. Those statistical analyses showed that water bodies with both elevated $BOD_5$ *and* TP tended to exhibit aquatic life impacts consistent with nutrient pollution as predicted by the conceptual model. Similarly, water bodies with both elevated diel DO flux *and* TP tended to exhibit aquatic life impacts consistent with nutrient pollution as predicted by the conceptual model.

MPCA accounted for site-specific factors (identified in the letter from CRR as "confounding factors) by adopting combined criteria, with stressor and response components that both must be exceeded before a water body is deemed to be not meeting the water quality standard. MPCA further accounted for site-specific factors by dividing the state into three different ecoregions for purposes of the eutrophication standards. MPCA's approach to regionalization is discussed in detail in the document, "Regionalization of Minnesota's Rivers for Application of River Nutrient Criteria," (MPCA, December 2013). MPCA classified its state waters into ecoregions as a method of reducing variability by sorting the State's rivers and streams into groups based on similarities in factors such as geology and climate. MPCA's definition of "ecoregion" in Minnesota's water quality standards is "an area of relative homogeneity in ecological systems based on similar soils, land use, land surface form, and potential natural vegetation." The basis for MPCA's ecoregion approach is further described in Section IV.A.3.c.1 of the January 23, 2015, Decision Document.

## II. EPA's Consideration of CRR's Request

CRR requests that EPA withdraw its approval of Minnesota's eutrophication criteria because CRR believes that (1) it is not appropriate to use BOD or the $BOD_5$ test as an indicator of nutrient impairment; (2) it is not appropriate to use diel DO flux as an aquatic life impairment parameter and the diel DO flux ranges included in the eutrophication criteria are not necessary to protect stream uses; (3) MPCA arbitrarily applied different $BOD_5$ and diel DO flux numbers to protect the same types of fishery classifications and (4) MPCA should have performed a "confounding factors analysis" in establishing its eutrophication criteria.

## A. $BOD_5$ Test Issues

CRR argues that $BOD_5$ is not an appropriate parameter to include in the eutrophication standard because CRR asserts that "[n]utrients (nitrogen and phosphorus) do not exert a BOD [biochemical oxygen demand]." CRR Letter at 5. However, as described above, nutrients do contribute to BOD, indirectly. CRR also argues that $BOD_5$ should not be included in the eutrophication standard because "BOD is not a 'toxic' measurement and does not directly impair aquatic life;" and the $BOD_5$ test (standing alone) "is incapable of reliably predicting nutrient impairment in the environment." CRR Letter at 5-6. However, these arguments are beside the point because $BOD_5$ is not an independent, standalone criterion under Minnesota's water quality standards. Instead, as described above, $BOD_5$ is included as part of Minnesota's combined criteria, under which *both* TP and at least one indicator response variable (either chlorophyll *a*, diel DO flux, pH or $BOD_5$) must be exceeded before the water body can be deemed as not meeting the water quality standard. MPCA included $BOD_5$ in the criteria because MPCA's extensive water quality and biological monitoring and statistical analyses showed that, when both TP and $BOD_5$ are found in water bodies at elevated levels, aquatic life are adversely impacted. Therefore, $BOD_5$ was included as a component of the combined criteria because it serves as a valid indicator of nutrient pollution: *i.e.*, it is valid predictor of nutrient impacts when it is coupled with data showing that elevated $BOD_5$ levels are co-occurring with elevated TP levels, and not because nutrients directly exert a BOD, because $BOD_5$ is directly toxic to aquatic life, or because $BOD_5$ alone in the absence of elevated concentration of TP is a reliable indicator of nutrient impairment.

CRR also raises issues about the $BOD_5$ test method. Specifically, CRR attached as Exhibit 4 to its letter a memorandum from the Standard Methods for the Examination of Water and Wastewater Joint Editorial Board that states:

> The BOD test is specifically intended to measure oxygen demand to the biochemical degradation of organic materials by microorganisms (bacteria) and includes the oxygen used to oxidize inorganic materials such as sulfides and ferrous iron. The test may also measure the amount of oxygen used to biologically oxidize reduced forms of nitrogen such as ammonia unless an inhibitor is used. Nutrients (N and P) do not exhibit an oxygen demand, per se, and where significant concentrations of viable algal cells are present in a sample, algal induced "BOD" does not represent the microbial degradation of organic substances that the test is intended to measure.

While it is true that the $BOD_5$ test method was developed as a means to measure oxygen demand due to non-nutrient parameters, the test actually measures all BOD, regardless of the precise nature and source of the organic matter that is responsible for the oxygen demand (directly or indirectly). As explained above, increases in algal biomass occurring as a result of phosphorus pollution is a form of organic matter that is detectable using the $BOD_5$ test. Consequently, Minnesota's data and analyses document that for water bodies that have elevated TP concentrations, it is reasonable to presume that elevated BOD levels detected by the $BOD_5$ test method are primarily attributable to the biological response to the presence of elevated TP concentrations in the water body.

CRR also argues that the $BOD_5$ test method results in BOD levels that are "artificially inflated by effects from live algae placed in the dark for five days." CRR Letter at 5. EPA does not agree. EPA's standard method for measuring $BOD_5$ specifically addresses the potential presence of algal cells in the $BOD_5$ test. The method requires that all light is to be excluded during the incubation of the samples to prevent the possibility of the production of DO due to photosynthesis so that the measure of BOD in the sample is not artificially offset by the production of DO through photosynthesis. The method does not otherwise speak to excluding or removing algal cells from the sample, which is appropriate as the algal cells themselves represent decomposable organic matter that will exert a biological oxygen demand when the cells die, as well as when they respire. In any event, to the extent that the type of "inflation" occurs when testing for nutrient-induced BOD using the $BOD_5$ method in the way that CRR suggests, any such "inflation" would have also been reflected in the $BOD_5$ sampling results that MPCA used in establishing correlations between $BOD_5$ levels and adverse impacts on aquatic life in Minnesota waterbodies that also have elevated TP levels. Thus, the $BOD_5$ component of Minnesota's combined criteria reflects any "artificial inflation" that CRR asserts occurs through use of the $BOD_5$ test method. This means that future $BOD_5$ sample results used for assessing attainment of the combined criteria can appropriately be compared to the $BOD_5$ component of Minnesota's combined criteria, regardless of whether CRR is correct on this point.

Finally, CRR incorrectly asserts that "no published EPA nutrient criteria document states that $BOD_5$ is a valid indicator of nutrient impairment," and that "EPA conceded that it possesses no documentation supporting the use of the [$BOD_5$ test] as a proper nutrient response criterion." CRR Letter at 5. EPA. While it may not be a commonly used response variable, in fact, the Lake Criteria Document (USEPA. 2000. Nutrient Criteria Technical Guidance Manual: Lakes and Reservoirs. Environmental Protection Agency, Office of Water, Washington, DC. EPA-822-B00-001) includes BOD as a "eutrophication-related variable" (Table 5-1) and the Estuaries Criteria Document (USEPA. 2001. Nutrient Criteria Technical Guidance Manual: Estuarine and Coastal Marine Waters. Environmental Protection Agency, Office of Water, Washington, DC. EPA-822-B01-003) includes BOD as an indicator of eutrophication (Table 4-1). Moreover, there was ample scientific documentation included in the administrative record for EPA's approval of Minnesota's eutrophication standard that supported the use of $BOD_5$ as a nutrient response indicator variable to be used as part of Minnesota's combined criteria. This included, but was not limited to, MPCA's reports on its analysis of extensive, Minnesota-specific water quality and Minnesota-specific biological monitoring data that showed that aquatic life had been harmed in water bodies where there were elevated levels of TP and $BOD_5$, harm that was not seen in water bodies where there were elevated levels of TP but not elevated levels of $BOD_5$; proceedings from U.S. EPA's expert workshop on nutrient enrichment indicators in streams, (http://www2.epa.gov/sites/production/files/2013-09/documents/indicatorsworkshop.pdf); and a number of scientific papers and other reports of studies that MPCA included in its administrative record (*see, e.g.,* Mallin, M, V. Johnson, S. Ensign, and T. Macpherson. 2006 Factors contributing to hypoxia in rivers, lakes and streams. Limnol. Oceangr. 51 (1, Part 2): 690-701; S. Heiskary and H. Markus. 2001 Establishing relationships among nutrient concentrations, phytoplankton abundance, and biochemical oxygen demand in Minnesota, USA rivers. Lake Reserv. Manage. 17(4):251-262).

In sum, $BOD_5$ is an appropriate indicator variable for Minnesota to use as one of several response variables for determining whether elevated TP levels in a particular water body are resulting in a biological response to nutrient pollution.

**B. Diel DO Flux Issues**

CRR argues that diel DO flux is not an appropriate response variable because its use "as a nutrient response variable to identify aquatic life impairment . . . has not been accepted by the scientific community and has not been endorsed in any EPA guidance documents dealing with the development of nutrient criteria." CRR Letter at 6. However, as described above and in EPA's January 23, 2015, Decision Document, there is ample scientific support for MPCA's decision to include diel DO flux as a response variable to be used as part of its combined criteria. This included, but was not limited to, analysis of extensive, Minnesota-specific water quality and Minnesota-specific biological monitoring data that showed that aquatic life had been adversely impacted in water bodies where there were elevated levels of TP and diel DO flux. Experts at a workshop convened by EPA to offer their scientific recommendations on indicators of nutrient enrichment suggested continuously monitored DO and diel DO specifically as measures of ecosystem function that should be used in combined criteria approaches. (https://www.epa.gov/nutrient-policy-data/expert-workshop-nutrient-enrichment-indicators-streams).

CRR also cites to EPA's Gold Book, which indicates "that DO minimum is the factor of concern and nowhere indicates DO flux as an independent aquatic life impairment metric." CRR Letter at 6. However, EPA's recognition that DO minimum can serve as a standalone indicator of impairment has no bearing on the separate question of whether diel DO flux is an appropriate component of combined criteria.

Finally, CRR argues that the diel DO flux component of the combined criteria should not have been approved because "MPCA's submission provided no information to confirm that the selected DO range is beyond that expected to be naturally occurring." CRR Letter at 7.

For the reasons provided below, EPA disagrees with CRR's assertion that EPA ought not to have approved Minnesota's eutrophication standards because of the diel DO flux component. This comment is similar to comments made by John Hall as part of his testimony on the proposed rules as reported in MPCA's response to comments document, "MPCA Response to Comments Submitted During the Public Comment Period, at the Public Hearings and during the Post-hearing Comment Period" (RTC) dated January 28, 2014:

> Pg. 149, line 18 "The numbers that were chosen by the PCA, the DO fluxes that they picked are so low they're just about background in the various streams. They don't really reflect an impairment level."

In its response, MPCA stated, "[t]he proposed DO Flux criteria are in line with strong, negative impacts that are demonstrated by analyses using Minnesota data. Attachment IV firmly establishes this along with all previous evidence in Exhibit EU-1." In attachment IV to the RTC, MPCA documented additional technical work it performed in response to this comment. MPCA repeated that analyses originally done in EU-1 relating DO to responses in fish and invertebrates using the larger set of data collected since then. In EU-1, MPCA's statistical analyses of the available data led to the following conclusion regarding the impact of DO flux on aquatic organisms:

> Several fish metrics (*e.g.*, % sensitive fish and number of sensitive taxa) and a few macroinvertebrate metrics exhibited strong negative relationships with DO flux (Table 16). Total macroinvertebrate taxa, number of EPT taxa, and number of clinger taxa were among the highest ranking macroinvertebrate metrics. Total number of macroinvertebrate taxa generally remain between the 25th-75th percentiles at DO flux <4.5 mg/L; however, above this range values are at or below the 25th percentile (Figure 42a). Sensitive fish (% and number of taxa) exhibit a wide range of values at DO flux less than about 4 mg/L; however, as DO flux increases above ~4.5 mg/L, sensitive fish decline to 10 percent or less of the sampled population (Figure 42b, c). The 2008 streams generally correspond to this pattern as well. Strong positive relationships noted for tolerant fish species and omnivores (Table 16). At DO flux of 4.5 mg/L or less, tolerant fish species were generally a small (10 percent or less) percent of the total population (Figure 42d). As DO flux increased above 4.5 mg/L, tolerant species increased as a portion of the total and values were above the 75th percentile for this metric. The 2008 data are more variable with respect to this metric and two of the coldwater streams - Wells Creek and Vermilion River - exhibit high percentages of tolerant species at low DO flux concentrations (Figure 42d), which suggests other factors likely drive the relative distribution of tolerant versus sensitive species in these coldwater streams.

The new analyses done after EU-1 increased the sample size for fish sites from 25 to 74 and for invertebrates from 21 to 61. The consideration of the new data not only supported the conclusions contained in EU-1, it provided even stronger support for the conclusion that DO flux greater than the threshold values in the eutrophication standards is associated with adverse effects on the exposed biological community. As a result of the new data, the number of thresholds identified increased from 4 to 10 and resulted in a greater number of significant results. As MPCA appropriately summarized in its January 28, 2014, Response to Comments, "in general, the conclusions drawn from the smaller sample size were accurate and the larger data set confirms the negative impact of DO flux on biological communities."

MPCA looked at the relationship between DO flux and biological response using two different statistical techniques-- additive quantile regression and regression tree (changepoint). Using additive quantile regression (Table 1), MPCA identified four significant thresholds for four fish metrics (% sensitive fish, % lithophils, % tolerant, and % intolerant). The range of significant thresholds for diel DO flux were all very close (4.1 mg/L– 4.7 mg/L). The results for the regression tree analysis were similar to those for additive quantile regression, except there were more significant relationships and the relationships included one invertebrate metric. As with additive quantile regression, the thresholds identified were similar across the metrics, ranging from 1.8 mg/L – 4.9 mg/L. Each of these relationships represents an observed statistically significant response of members of the aquatic community to diel DO flux.

With respect to the statement by CRR, "MPCA's submission provided no information to confirm that the selected DO range is beyond that expected to be naturally occurring," this statement is unsupported by any data or analysis of the type done by MPCA or any data whatsoever. The CRR letter cites to exhibit six, a letter from Thomas Gallagher of HDR Engineering as the basis for its assertion that the DO flux thresholds are inappropriate. In his letter, Mr. Gallagher states:

> My professional opinion is that DO flux and BOD5 should not be used as indicators of eutrophication in lieu of direct measurements of chl-a. Nutrient criteria, like all other water quality criteria are set at the level necessary to protect aquatic life uses, using scientifically defensible methods (see, 40 CFR 131.11 and the Guidelines for the Development of Numerical National Water Quality Criteria - USEPA 1985). Procedures used to establish water quality criteria (1) identify how the pollutant change adversely impacts such uses and (2) set the numeric criteria at the threshold where unacceptable adverse impacts are predicted to occur. MPCA has DO criteria to protect aquatic life that were based on application of these methods. Therefore the addition of DO flux as a response variable for eutrophication is inappropriate, unless it is demonstrated that DO flux, in [sic] of itself,- is adverse to aquatic life at the levels MPCA seeks to establish.

Two misconceptions in the above quote from Mr. Gallagher must be addressed. First, EPA notes that EPA's, *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* are intended for use to derive criteria for pollutants that cause direct toxicity to aquatic organisms and so are not appropriate for use to develop nutrient criteria. Second, contrary to the characterization that water quality criteria are set, "at the threshold where unacceptable adverse impacts are predicted to occur," the section 303(c)(2)(A) of the Clean Water Act and Federal regulations at 40 CFR 131.11(a) require that criteria be set at a level that protects the uses of the waters (40 CFR 131.11(a): "Such criteria must be based on sound scientific rationale and must contain sufficient parameters or constituents *to protect the designated use.*" (Emphasis added).

As described above, the original analyses conducted by MPCA in EU-1 and the further analyses conducted by MPCA in response to comments from John Hall on the proposed rules both document that diel DO flux greater than the threshold values that are part of Minnesota's combined criteria are associated with adverse effects on aquatic life. Consequently, diel DO flux is an appropriate response indicator for Minnesota to use as one of several response variables for determining whether elevated TP levels in a particular water body are resulting in a biological response to nutrient pollution.

Mr. Gallagher goes on to state, "[m]oreover, there is no apparent basis to claim organisms in Northern ecoregional streams require a lower diel DO variation to protect aquatic resources compared to Southern or Central ecoregional streams. The ecological basis for such a presumption is not apparent." MPCA's "Regionalization of Minnesota's Rivers for Application of River Nutrient Criteria," (MPCA, December 2013) and section 2.C. of MPCA's SONAR explains the basis for Minnesota's river nutrient regions and section 4.E. of MPCA's SONAR and describes the basis for the specific numbers that comprise the eutrophication standard for each nutrient ecoregion in Minnesota. To summarize, MPCA evaluated multiple lines of evidence, including biological responses and reference conditions, to determine an appropriate total phosphorus threshold value for each river nutrient region. MPCA derived the response indicator thresholds for each river nutrient ecoregion from the regression relationship MPCA calculated for each TP-response indicator pair using the TP threshold value for each river nutrient region. MPCA used the observed biological response thresholds derived from the statistical analyses of the relationships between the response indicators and the biological metrics to confirm the calculated threshold value derived from the regression relationship.

### C. Application of Different Criteria to Protect the Same Types of Fishery Classifications

CRR argues that it was "arbitrary and lacking in sound scientific rationale [for MPCA to adopt] different $BOD_5$ and diel DO flux numeric variables as necessary to protect *the same type of fishery classification*." CRR Letter at 8. CRR asserts that "no physiological basis was provided to justify different 'protective criteria' for response variables in waters similarly classified [and that] [a]bsent some rational explanation of, mechanistically, how this could occur and credible scientific studies supporting the conclusion . . . , it is arbitrary and capricious to impose more restrictive aquatic life protection needs based on geographic location." CRR Letter at 8.

As explained in Section IV.A.3.c.i of the January 23, 2015, Decision Document and in Minnesota's 2013 document, "Regionalization of Minnesota's Rivers for Application of River Nutrient Criteria," MPCA divided the state into three ecoregions for purposes of developing eutrophication criteria, reflecting differences in biological communities, land use, soils and geomorphic patterns across the state. MPCA demonstrated that there were differences between the three ecoregions in background levels of TP and biological response to nutrients, which is consistent with scientific literature and EPA's Stressor-response Guidance, which speaks to the utility of classification of waters as a means of reducing the range of environmental conditions between waters within a group and thereby reducing the variability in the estimated stressor-response relationships. MPCA then performed statistical analyses of water quality monitoring data for TP, $BOD_5$ and diel DO flux for the water bodies in relation to biomonitoring data within each ecoregion to develop ecoregion-specific thresholds for each parameter, which in turn served as the combined criteria for each specific ecoregion. The differences in the combined criteria between the three ecoregions, therefore, are based on sound scientific rationale. Moreover, where a state provides a sound scientific rationale for dividing the state into distinct ecoregions reflecting differences between the ecoregions and performs statistical analyses of appropriate water quality and biomonitoring data to derive ecoregion-specific combined criteria for nutrients, it is not incumbent on the state to also provide a physiological basis or mechanistic explanation for any differences in the criteria between the ecoregions.

### D. Confounding Factors

CRR argues that MPCA failed to adequately account for confounding factors in developing its eutrophication criteria. CRR Letter at 8-9. EPA disagrees, as MPCA accounted for confounding factors in several ways in establishing and quantifying relationships between indicators of nutrient response and measures of biological integrity (biological metrics) to help ensure the relationships upon which the thresholds are based are actually nutrient driven.

First, MPCA developed a scientifically sound conceptual model, based on decades of scientific research regarding the effects of nutrients on biological communities, on how nutrient pollution can result in impairments of aquatic life uses of rivers and streams in Minnesota. Second, MPCA also evaluated a large number of biological metrics and only selected metrics that showed a relationship to total phosphorus. For the metrics that showed a relationship to phosphorus, MPCA rejected those for which there was not a plausible mechanism for the metric to respond to nutrient pollution, MPCA also discarded biological metrics that were redundant of other biological metrics, yielding a final list of eight fish and six invertebrate metrics that were used to develop biologically-thresholds for the nutrient response indicators. Third, thresholds were quantified using two separate statistical tools: quantile regression and regression tree (change point) analyses. Standard statistical principles of significance were applied, ensuring only relationships that had a very low probability of occurring by chance were selected. Quantile regression was specifically chosen because it limits the impact of factors other than the factor of interest by focusing on the portion of the data distribution where the response of the biological metric is most probably attributable to the nutrient response indicator. As MPCA explained in EU-1:

> The use of field-collected biological data in developing chemical criteria is often difficult due to complex relationships among chemical and physical measures and the biota. A relatively new analysis method, called quantile regression, has been used as a tool to identify threshold concentrations and to develop criteria to protect aquatic life. Quantile regression is well suited for the wedge-shaped plots (caused by heterogeneous variance; *i.e.*, heteroscedasticity) that are common with biological monitoring data (Terrell *et al.* 1996, Koenker & Hallock 2001, Cade & Noon 2003, Bryce *et al.* 2008; see Figure 8). These wedge-shaped plots are the result of the limitation of biological attributes (*e.g.*, taxa richness) by the variable of interest on the outer or upper edge of the wedge (Bryce *et al.* 2008; see Figure 8). Limitations to biological measures inside the wedge are caused by other unmeasured variables (Figure 8). In the case of this work, nutrients can lower biological condition through alteration of DO levels or shifts in food resources or habitat. However, there are also a number of other factors (*e.g.*, sediment, habitat) that can also limit biological condition in Minnesota streams and rivers. As a result of these different factors reducing biological measures, there is unequal variation of the response variable at different levels of the predictor variable. This unequal variation often makes field-derived data (*e.g.*, biomonitoring data) less suitable for the more traditional least squares regression. Quantile regression differs from least squares regression in that it estimates the median (*i.e.*, 50th quantile) or other quantiles whereas least squares regression estimates the mean. Another advantage of quantile regression is that extreme outliers do not impact regression quantile estimates (Terrell *et al.* 1996).

Finally, two statistical techniques were used to allow thresholds to be cross-checked. Thresholds were also compared to monitoring data in minimally impacted streams as a further cross-check.

CRR suggests that EPA's 2010 Stressor-response Guidance "requires" some that sort of stand-alone "confounding factors analysis" be performed in developing nutrient criteria. However, the Stressor-response Guidance is a set of recommendations for how states could develop nutrient criteria in a scientifically defensible manner, not a set of "requirements" (see Stressor-response guidance, page ii). Moreover, the Guidance recommendation is only that confounding factors be considered in the development of nutrient criteria, which is exactly what MPCA did. Nothing in the Guidance suggests that this can only be accomplished through a separate "confounding factors analysis."

In sum, MPCA accounted for confounding factors in a manner that was scientifically sound and consistent with EPA's 2010 Stress-response Guidance.

### III. Conclusion

For the reasons explained above, EPA denies your request that EPA withdraw its January 23, 2015, approval of Minnesota's eutrophication standard. Please contact Gary Prichard in our Office of Regional Counsel at prichard.gary@epa.gov or (312) 886-0570 if you have any questions about this response.

Sincerely,

Tinka G. Hyde
Director, Water Division

Enclosure

**DRAFT: FEBRUARY 5, 2015**

ADMINISTRATIVE INDEX FOR EPA'S APPROVAL OF WATER QUALITY STANDARDS FOR EUTROPHICATION AND TOTAL SUSPENDED SOLIDS FOR MINNESOTA RIVERS AND STREAMS AND THE MISSISSIPPI RIVER POOLS

## I. Documents submitted by MPCA on August 20, 2014

- Letter from John Linc Stine, Commissioner MPCA, to Susan Hedman, Regional Administrator, EPA Region 5, Request for formal EPA approval, August 20, 2014, received August 28, 2014
- Copy of letter from Carol Nankivel, Rule Coordinator at MPCA, to Brian Thompson, U.S. EPA Region 5, transmitting documents pertinent to the adoption of amendments to State water quality standards (Minnesota Rules chapters 7050 and 7053), dated May 13, 2014
- Findings of Fact and Order Adopting Rules regarding the adoption of amendments to Minnesota rules chapters 7050 and 7053, dated June 25, 2014
- Adopted Permanent Rules Relating to Water Quality, Minnesota Pollution Control Agency (Minnesota Rules chapters 7050 and 7053), May 5, 2014
- Legal certification, Jean Coleman, Staff Attorney at MPCA, to Susan Hedman, Regional Administrator, EPA Region 5, August 25, 2014 (3 pp.)
- Minnesota State Register, Notice of Adopted Permanent Rules Relating to Water Quality, August 4, 2014

## II. Other documents from MPCA

- Letter from Carol Nankivel, Rule Coordinator at MPCA, to Brian Thompson, U.S. EPA Region 5, transmitting documents pertinent to the adoption of amendments to State water quality standards (Minnesota Rules chapters 7050 and 7053), dated May 13, 2014
- Draft water quality standards pertaining to amendments of Minn. R. Ch. 7050 and Minn. R. Ch. 7053, dated May 29, 2013.MPCA Environmental Analysis and Outcomes Division, Statement of Need and Reasonableness (SONAR), In the Matter of Proposed Revisions of Minn. R. Ch. 7050, Relating to the Classification and Standards for Waters of the State; and 7053 Relating to Effluent Limits and Treatment Requirements for Discharges to Waters of the State
  - Book 1, General Information.
  - Book 2, Eutrophication Standards for Streams, Rivers, Lake Pepin, and Navigational Pools
  - Book 3, Total Suspended Solids (TSS)
  - Book 4, Rule by Rule Discussion of Proposed Changes.

- SONAR Exhibits, Book 1

  A-1 Triennial Water Quality Rules Amendments (2008-2011), Minnesota Rules Chapters 7050 and 7052, Official Public Meeting Minutes, September 8, 2008, September 9, 2008, and September 15, 2008

  A-2 Statement of Need and Reasonableness, in the Matter of Proposed Revisions of MN Rules Chapter 7050, Relating to the Classification and Standards for Waters of the State; the Proposed Addition of a New Rule, Minnesota Rules chapter 7053, Relating to Point and Nonpoint Sources Treatment Requirements; and the Repeal of Minn. R. Chapters 7056 and 7065, Books I-III July 2007

A-3 MPCA Comment on Amendments to State Water Quality Rules (Chapter 7050 and 7052 of Minnesota Rules), August 29, 2008

A-12 Comments received from the Minnesota Environmental Science and Economic Review Board (MESERB) on planned amendments to rules governing water quality, Minnesota rules chapters 7050 and 7052, September 26, 2008

A-13 Comments received from MESERB on planned amendments to rules governing water quality, Minnesota rules chapters 7050 and 7052, November 26, 2008

A-14 Comments received from the Minnesota Center for Environmental Advocacy (MCEA) on planned amendments to rules governing water quality, Minnesota rules chapters 7050 and 7052, September 26, 2008

A-16 MPCA request for comments on planned amendments to rules governing water quality, Minnesota rules chapters 7050 and 7052, undated

A-18 MPCA request for comments on planned amendments to rules governing water quality, Minnesota rules chapters 7050 and 7052, July 18, 2008

A-19 Minnesota State Register, Notice of Planned Amendments for Numeric Standards, March 2, 2009

A-21 Comments received from the Minnesota Farm Bureau Federation on planned amendments to rules governing water quality, Minnesota rules chapters 7050 and 7052, September 26, 2008

A-22 Comments received from the Coalition of Greater Minnesota Cities supporting a request by the Pennsylvania Water Environment Association for peer review of EPA Region III approach to developing nutrient standards, October 6, 2008

A-27 Comments received from the Lake County Board of Commissioners on planned amendments to rules governing water quality, Minnesota rules chapters 7050 and 7052, April 14, 2009

A-28 Comments received from MCEA on planned amendments to rules governing water quality, Minnesota rules chapters 7050 and 7052, April 14, 2009

A-30 Comments received from MESERB on planned amendments to rules governing water quality, Minnesota rules chapters 7050 and 7052, April 17, 2009

A-31 Comments received from the Minnesota Corn Growers Association on Minnesota water quality standards, April 16, 2009

A-32 MPCA request for comments on planned amendments to rules governing water quality, Minnesota rules chapters 7050, 7052 and 7053, June 11. 2012

A-35 Comments received from the Just Change Law Offices on planned amendments to rules governing water quality, Minnesota rules chapters 7050, 7052 and 7053, July 18, 2012

- SONAR Exhibits, Book 2

EU-1 Minnesota River Nutrient Criteria Development for Rivers. Heiskary, S., W. Bouchard, Jr. and H. Markus. 2010. MPCA.

EU-2 Relation of Nutrient Concentrations and Biological Responses in Minnesota Streams: Applications for River Nutrient Criteria Development. Heiskary, S. 2008. MPCA.

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| EU-3 | Establishing relationships among in-stream nutrient concentrations, phytoplankton abundance and composition, fish IBI and biochemical oxygen demand in Minnesota USA rivers. S. Heiskary and H. Markus. 2003. MPCA. |
| EU-4 | Establishing relationships among nutrient concentrations, phytoplankton abundance, and biochemical oxygen demand in Minnesota, USA rivers. S. Heiskary and H. Markus. 2001. Lake Reserv. Manage. 17(4):251-262. |
| EU-5 | Regionalization of Minnesota's rivers for application of river nutrient criteria. Heiskary, S. and K. Parson. 2010. MCPA. |
| EU-6 | Lake Pepin Site Specific Eutrophication Criteria. Heiskary, S. and D. Wasley. 2011. MPCA. |
| EU-7 | Mississippi River Navigational Pool Eutrophication Criteria. Heiskary, S. and D. Wasley, 2012. MPCA. |
| EU-8 | Phosphorus Strategy Task Force Report. Water Quality Division. MPCA. June 1996. |
| EU-9 | USEPA National Strategy for the Development of Regional Nutrient Criteria. USEPA 822 R-98-002. 1998. |
| EU-10 | USEPA Rivers and Streams in Nutrient Ecoregion VI, NGP, WCBP, and LAP. USEPA 822 B-00-017. 2000. |
| EU-11 | USEPA Rivers and Streams in Nutrient Ecoregion VII, CHF, and DA. USEPA 822 B-00-018. 2000. |
| EU-12 | USEPA Rivers and Streams in Nutrient Ecoregion VIII, NLF; and NMW. USEPA 822 B-01-015. 2001. |
| EU-13 | USEPA Fact sheet, Ecoregional Nutrient Criteria, December 2001. |
| EU-14 | USEPA Nutrient Criteria Technical Guidance Manual, Rivers and Streams. USEPA-822-B00-000. 2000. |
| EU-15 | USEPA Memo from Benjamin Grumbles to Water Directors, etc. Nutrient Pollution and Numeric Water Quality Standards, May 25, 2007. |
| EU-16 | USEPA Policy as it Relates to the Phosphorus Objectives for the Nation's Receiving Waters. April 20, 1973 USEPA Region V letter to MPCA. |
| EU-17 | State Adoption of Numeric Standards (1998-2008) USEPA-821-F-08-007. |
| EU-18 | Science Advisory Board Recommendations to USEPA on river nutrient criteria guidance. Final draft April 2010. |
| EU-19a | Water Quality Standards for the State of Florida's Lakes and Flowing Waters. October 2010 (USEPA 2010a). |
| EU-19b | Technical support Document for UEPA's Proposed Numeric Nutrient Criteria for FL Inland Surface Fresh Waters (USEPA 2010b). |
| EU-20 | Using Stressor-response Relationships to Derive Numeric Nutrient Criteria November 2010 (USEPA 2010b). |
| EU-21a | USEPA approval of MPCA 2003 Nutrient Criteria Development Plan: 2003. May 5, 2003 Jo Lynn Traub USEPA R5 Water Division letter to Mike Sandusky. |
| EU-21b | Minnesota's Plan for Development of Nutrient Criteria: 2008 update to USEPA R 5 (July 2008). |
| EU-21c | USEPA R5 approval of MPCA 2008 Nutrient Criteria Development Plan Update. Timothy Henry, Acting Director Water Quality Division letter to Mike Sandusky August 22, 2008. |

EU-22a USEPA Headquarters review of "Minnesota Nutrient Criteria Development for Rivers." Draft October 21, 2009. by Dr. Walter Dodds, December 14, 2009 for USEPA.

EU-22b MPCA response to Dr. Walter Dodds comments: June 21, 2010.

EU-23a USEPA Headquarters review of "Minnesota Nutrient Criteria Development for Rivers." Draft October 21, 2009. by Dr. Michael Paul, February 9, 2010 for USEPA.

EU-23b MPCA response to Dr. Michael Paul comments: June 7, 2010.

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EU-24 MPCA response to Dr. Jan Stevenson comments: June 21, 2010.

EU-25 A Method and Rationale for Deriving Nutrient Criteria for Small Rivers and Streams in Ohio. Miltner, R.J. 2010. Environ. Manage. 45:842-855.

EU-26 Criteria for control of nutrient enrichment in streams. Ohio USEPA working draft submitted to USUSEPA Region 5: November 4, 2010.

EU-27 Phosphorus water quality standards for Wisconsin rivers, streams, various types of lakes, reservoirs, and Great Lakes; as included in WI Chapter NR 102 (WDNR November 2010).

EU-28 USEPA Nutrient Criteria Technical Guidance Manual, Lakes and Reservoirs. USEPA-822-B00-001. 2000.

EU-29 Announcement for presentation draft river eutrophication criteria at National Park Service Mississippi River Forum: October 15, 2010. Lark Weller, MNRAA Water Quality Coordinator, NPS.

EU-30 Selected water quality characteristics of minimally impacted streams from Minnesota's seven ecoregions. S. McCollor and S. Heiskary.1993. MPCA, St. Paul MN.

EU-31 Minn. R. Ch. 7050.

EU-32 MPCA TMDL guidance "Lake Nutrient TMDL Protocols and Submittal Requirements."

EU-33 Dubrovsky, N. and P. Hamilton. 2010. Nutrients in the Nation's streams and groundwater: National Findings and Implications: U.S. Geological Survey Fact Sheet 2010-3078.

EU-34 Minnesota's Water Quality Monitoring Strategy 2004 to 2014: A Report prepared for the U.S. Environmental Protection Agency. August 2004.

EU-35 Total Suspended Solids-Submersed Aquatic Vegetation Site-Specific Standard South Metro Mississippi River Public Notice Draft January 2010.

EU-36 Hambrook-Berkman, J. and M. Canova. 2007. Ch. 7.4 Algal Biomass Indicators. U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A7, section 7.1, February, accessed Feb. 11, 2011 from http://pubs.water.usgs.gov/twri9A7/.

EU-37 Minnesota Water Sustainability Framework. 2011. Developed by University of Minnesota Water Resources Center.

EU-38 Detailed Assessment of Phosphorus Sources to Minnesota Watersheds. 2004. A Legislative Report developed by Barr Engineering for MPCA.

EU-39 MCEA submittal requesting promulgation of river nutrient standards in 2007-2008 triennial rule revision.

EU-40 Mallin, M, V. Johnson, S. Ensign, and T. Macpherson. 2006 Factors contributing to hypoxia in rivers, lakes and streams. Limnol. Oceangr. 51 (1, Part 2): 690-701.

EU-41a Cost estimates for municipal facilities using chemical phosphorus removal to meet a 1 mg/L effluent limit. Memo to Steve Heiskary, EAO Division MPCA. From Randy Thorson Municipal Division. MPCA August 4, 2011.

EU-41b Cost estimates for municipal stabilization pond facilities using chemical phosphorus removal to meet a 1 mg/L effluent limit. Memo to Steve Heiskary, EAO Division MPCA. From Randy Thorson Municipal Division. MPCA August 16, 2011.

EU-41c Cost estimates for municipal facilities with design flows from 0.2 MGD to 315 MGD using chemical phosphorus removal to meet a 0.8 mg/L or 0.1 mg/L effluent limit. Memo to Steve Heiskary, EAO Division MPCA. From Randy Thorson Municipal Division. MPCA October 28, 2011.

EU-41d Municipal stabilization pond facilities using chemical phosphorus removal to meet a 0.15 mg/L or 0.1 mg/L effluent limit. Memo to Steve Heiskary, EAO Division MPCA. From Randy Thorson Municipal Division. MPCA November 21, 2011.

EU-42 Potential Cost to Industrial Point Source Dischargers Attributed to Adoption of a 0.1 mg Total Phosphorus (TP) per Liter Water Quality Standard. Scott Knowles, MPCA.

EU-43 Coordination of Minnesota and Wisconsin phosphorus standard: Lake Pepin. 11 3661 – 87th Legislative Session (2011-2012), Sec. 31.

EU-44 Dr. Lester Yuan, USEPA, May 5, 2011 e-mail communication to Steve Heiskary.

EU-45 Implementation of river nutrient standards. November 2011. Dennis Wasley and Steve Weiss, EAO, MPCA.

EU-46 Phosphorus decision tree and narrative. March 2010. Dennis Wasley, EAO, MPCA.

EU-47 A Science Framework for Developing Long-term, Ecologically Sensitive Nutrient Objectives for Lake Winnipeg and its Tributaries. A draft for discussion at the November 2010 Nutrient Objectives Workshop. Manitoba Water Stewardship and Environment Canada. October 27, 2010 (draft).

EU-48a Nutrient Criteria for Surface Waters in Maine. 06-096 Chapter 583. Maine Department of Environmental Protection (DEP). November 2011.

EU-48b USEPA Region 1 Response to Maine DEP Rule 06-096 Chapter 583

EU-49 USEPA Region V Letter to Illinois EPA. January 21, 2011.

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EU-51a State of Florida Chapter 62-302. Surface Water Quality Standards. 2011. Florida Department of Environmental Protection. Approved for adoption by Environmental Regulation Commission. December 8, 2011.

EU-51b Chapter 62-303. Identification of Impaired Surface Waters. Parts 62-303.150-62-303.720. Florida Department of Environmental Protection. 2011.

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EU-52b Water Quality Assessment Method. Montana Department of Environmental Quality. November 28, 2011.

EU-53 Statement of Need and Reasonableness. Book II of III. In the Matter of the Proposed Revisions of Minn. R ch 7050 Relating to the Classification and Standards for the Waters of the State. The Proposed Addition of a New Rule Minn. R ch.7053, Relating to Point and Nonpoint Source Treatment Requirements. MPCA, 2007.

EU-54 The Lake City Graphic, "City doing something about stagnant water" June 30, 1988 and "Aerators making harbor sweeter" July 7, 1988.

EU-55 Total phosphorus concentrations in lakes and their inflows: a review of approved Minnesota lake nutrient TMDLs. Memorandum to Steve Heiskary Environmental Analysis and Outcomes Division. From: John Erdmann, Metro Watershed, Regional Division, MPCA. October 8, 2012.

EU-56 Angradi, T. 2013. An exploratory analysis of Indiana and Illinois biotic assemblage data in support of state nutrient criteria development. USEPA ORD Duluth MN, January 24, 2013.

EU-57 Engineering News Record (ENR). Cost Indexes, page 19. December 6, 2010.

EU-58 CH2MHILL. Final Report: Statewide Nutrient Removal Cost Impact Study. Prepared for Utah Division of Water Quality. October 2010.

EU-59 Strand Associates, Inc. Report for Municipal Environmental Group, Wisconsin – Opinions of Probable Cost for Achieving Lower Effluent Phosphorus Concentrations at Wastewater Treatment Plants in Wisconsin. August 2008.

EU-60 Faeth, Paul . 2000. Fertile Ground: Nutrient Trading's Potential to Cost-Effectively Improve Water Quality, World Resources Institute, Washington D.C.

EU-61 Keplinger, K., J. Houser, A. Tanter, L. Hauck and L. Beran. 2004. Cost and Affordability of Phosphorus Removal at Small Wastewater Treatment Plants, Small Flows Quarterly, Fall: 36-49.

- SONAR Exhibits, Book 3

TSS-1 Aquatic Life Water Quality Standards Draft Technical Support Document for Total Suspended Solids (Turbidity). H. D. Markus, Ph.D. Revised Draft, May 2011.

TSS-2 Letter from EPA, Miss River TSS Approval letter.pdf, November 8, 2010.

TSS-3 Giblin et al. Evaluation of Light Penetration on Navigation Pools 8 and 13 of the Upper Mississippi River. 2010.

TSS-4 R. Thorson, Final cost estimates for municipal facilities to meet and monitor for the final draft Total Suspended Solids (TSS) {Turbidity} criteria, 2012. MPCA.

TSS-5 S. Knowles, Final cost estimates for industrial facilities to meet and monitor for the final draft Total Suspended Solids (TSS) {Turbidity} criteria, 2012. MPCA.

TSS-6 G. Rott, Recommendations on how to apply the proposed TSS Water Quality Standard as an effluent limit, 2011. MPCA.

TSS-7 G. Rott, Possible problem dischargers for the proposed TSS Water Quality Standards, e-mail dated June 1, 2012; forward from Scott Knowles on October 16, 2012.

- Office of Administrative Hearing Documents
  - Minnesota Office of Administrative Hearings (OAH), In the Matter of the Proposed Rules of the PCA for Rule Amendments Governing Water Quality Standards – River Eutrophication, Total Suspended Solids & Minor Corrections and Clarifications to Minnesota Rules 7050 and 7053, OAH 60-2200-30791, Revisor R-4104, Administrative Law Judge Order on the Minnesota Environmental and Economic Review Board and the Minnesota soybean Growers Association's Comments, February 11, 2014.
  - Minnesota OAH, In the Matter of PCA for Rule Amendments Governing Water Quality Standards – River Eutrophication, Total Suspended Solids & Minor Corrections, OAH 60 -2200-30791, Revisor R-4104, Cover letter for the Administrative Law Judge determination of no negative findings, May 2, 2014.
  - Minnesota OAH, In the Matter of the Proposed Rules of the PCA for Rule Amendments Governing Water Quality Standards – River Eutrophication, Total Suspended Solids & Minor Corrections and Clarifications to Minnesota Rules 7050 and 7053, OAH 60 -2200-30791, Revisor R-4104, Administrative Law Judge determination of no negative findings, May 2, 2014.
  - Minnesota OAH, In the Matter of the Proposed Rules of the PCA for Rule Amendments Governing Water Quality Standards – River Eutrophication, Total Suspended Solids & Minor Corrections and Clarifications, OAH 60 -2200-30791, Revisor R-4104,, Order Granting Extension to the Deadline for Completing the ALJ Report, April 28, 2014.
  - Minnesota OAH, In the Matter of the Proposed Rules of the PCA for Rule Amendments Governing Water Quality Standards – River Eutrophication, Total Suspended Solids & Minor Corrections and Clarifications to Minnesota Rules 7050 and 7053, OAH 60 -2200-30791, Revisor R-4104, Order reopening administrative record for a limited period, March 25, 2014.
  - Minnesota OAH, In the Matter of the Proposed Rules of the PCA for Rule Amendments Governing Water Quality Standards – River Eutrophication, Total Suspended Solids & Minor Corrections and Clarifications to Minnesota Rules 7050 and 7053, OAH 60 -2200-30791, Revisor R-4104, Order on review of notice of hearing, October 2, 2013.
  - Minnesota OAH, In the Matter of PCA for Rule Amendments Governing Water Quality Standards – River Eutrophication, Total Suspended Solids & Minor Corrections, OAH 60 -2200-30791, Revisor R-4104, Additional Notice Plan Approval, October 2, 2013.

- Comments that MPCA included as hearing exhibits

  HE-8-1 Brian Thompson, EPA Region V, January 6, 2014
  HE-8-2 Timothy Sundby, Carver Co., January 6, 2014
  HE-8-3 Linda Holst, EPA Region V, January 7, 2014
  HE-8-4 Paul Nelson, Scott Co., January 8, 2014
  HE-8-5 Curtis Sparks, Poplar River Management Board, January 5, 2014
  HE-8-6 Steven Nyhus, Mn. Environmental Science and Economic Review Board, Flaherty and Hood, December 12, 2013

HE-8-7 Jill Thomas/Fred Corrigan, Minnesota Asphalt Pavers/Aggregate and Ready Mix Association, January 8, 2014
HE-8-8 Kris Sigford, Minnesota Center for Environmental Advocacy (Attachments HE-8-8A to 8-8E, January 8, 2014
HE-8-9 Leslie Everett, University of Minnesota Water Resources Center, January 9, 2014
HE-8-10 Alan Oberloh, City of Worthington, January 8, 2014
HE-8-11 Linda Holst, EPA Region V, January 22, 2014
HE-8-12 Paul Nelson, Scott Co., January 28, 2014
HE-8-13 Curtis Sparks, Poplar River Management Board (Attachments HE-8-13A to 8-13E), January 28, 2014
HE-8-14 Jim Hafner/Randy Neprash, Mn. Cities Stormwater Coalition, January 28, 2014
HE-8-15 Lynn Clarkowski, Minnesota Department of Transportation (Attachments 8-15A to 8-15J), January 28, 2014
HE-8-16 Leisa Thompson, Metropolitan Council Environmental Services, January 28, 2014
HE-8-17 Shannon Lotthammer, MPCA Preliminary Response to Comments (Attachments 8-17A to 8-17 D)
HE-8-18 Leslie Everett, University of Minnesota Water Resources Center, February 3, 2014
HE-8-19 Shannon Lotthammer, MPCA Final Response to Comments (Attachments 8-19A to 8-19D)
HE-8-20 David Lane, Mn. Environmental Science and Economic Review Board (Attachments 8-20A to 8-20B), January 28, 2014
HE-8-21 George Goblish, Mn. Soybean Growers Association, January 27, 2014
HE-8-22 Dana Thomas, EPA Headquarters, February 19, 2014
HE-8-23 Shannon Lotthammer, MPCA Response for Extended Comment Period (Attachments 8-23A to 8-23B), February 20, 2014
HE-8-24 David Lane, Mn. Environmental Science and Economic Review Board (rebuttal), February 4, 2014
HE-8-25 Matthew Wohlman, Mn. Department of Agriculture, March 27, 2014
HE-8-26 Paul Nelson, Scott Co. March 28, 2014
HE-8-27 Walter Popp/Rob Burdis, Mn. Department of Natural Resources, March 28, 2014
HE-8-28 David Lane, Mn. Environmental Science and Economic Review Board (Attachment 8-28A to 8-28B), March 28, 2014

- Other Hearing Exhibits

HE-1a Request for comments published in the July 28, 2008, State Register
HE-1b Request for comments published in the March 2, 2009, State Register
HE-1c Request for comments published in the June 11, 2012, State Register
HE-2 Proposed rules, including the Revisor's approval
HE-3 Statement of Need and Reasonableness ("SONAR") signed and dated July 23, 2013
HE-4 Certificate of Mailing the SONAR to the Legislative Reference Library and copy of the transmittal letter
HE-5a Notice of Hearing as mailed, Govdelivery message and Govdelivery summary of recipients

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| HE-5b | Notice of Hearing as published in the State Register |
| HE-6a | Certificate of Mailing Notice |
| HE-6b | Certificate of Accuracy of the mailing list |
| HE-7a | Certificate of Additional Notice |
| HE-7 | OAH approval of Additional Notice Plan |
| HE-8 | Comments Received (Each comment received is numbered consecutively as HE-8-1, HE-8-2, etc.). List of comments provided below |
| HE-9a | Notice to Legislators |
| HE-9b | Management and Budget approval of the proposed rules |
| HE-9c | Notice sent to municipalities in accordance with Minn. Stat. § 115.44, subd. 7. |
| HE-10 | List of Errata to SONAR, rule language and Exhibits |
| HE-11 | Summary presentation slides |
| HE-12 | Ecoregions of the Conterminous United States, James M. Omernik, published in the Annals of the Association of American Geographers, 77(1), 1987, pp. 118-125. USEPA document number EPA/600/3-88/037 |
| HE-13 | Descriptive Characteristics of the Seven Ecoregions in Minnesota, Fandrei et al, published by the Minnesota Pollution Control Agency, March 1988 |
| HE-14 | OAH Order on the Minnesota Environmental and Economic Review Board and the Minnesota Soybean Growers Association's Comments (extended comment period- dated 2/11/14) |
| HE-15 | OAH Order Reopening the Administrative Record (dated 3/25/14) |
| HE-16 | Affidavit of Carol Nankivel (dated 3/28/14) |
| HE-17 | Affidavit of Jean Coleman (dated 3/28/14) |
| HE-18 | Copy of MPCA Govdelivery message (dated 6/7/13) |
| HE-19 | Copy of OAH Decision 1999 WL 194069 |
| HE-20 | MPCA informational memo re: reopened administrative record |
| HE-21 | OAH Report Extension |
| HE-22 | OAH Report Extension II |

- Transcripts of the Public Hearing (morning and evening sessions), January 8, 2014
- Rules showing revisions, May 5, 2014
- Explanation of Hearing Exhibits and Sequence of Events
- Rule Hearing Exhibits Index, OAH Docket 60-2200-30791, January 8, 2014

## III. EPA Guidance and Other EPA Documents

- U.S. EPA's *What Is A New or Revised Water Quality Standard Under CWA 303(c)(3)? Frequently Asked Questions*, October 2012, at http://water.epa.gov/scitech/swguidanceistandards/cwa303faq.cfm.
- U.S. EPA, 2010. "Using Stressor-response Relationships to Derive Numeric Nutrient Criteria," (Stressor-response Guidance), at: http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/upload/Using-Stressor-response-Relationships-to-Derive-Numeric-Nutrient-Criteria-PDF.pdf.
- U.S. EPA Science Advisory Board (SAB) Review of EPA's Empirical Approaches for Nutrient Criteria Derivation, April 27, 2010, at

http://yosemite.epa.gov/sab/sabproduct.nsf/0/e09317ec14cb3f2b85257713004bed5f/$FILE/EPA-SAB-10-006-unsigned.pdf.

- Proceedings from U.S. EPA expert workshop: nutrient enrichment indicators in streams, September, 2014, at http://www2.epa.gov/sites/production/files/2013-09/documents/indicatorsworkshop.pdf.
- U.S. EPA Ambient Water Quality Criteria Recommendations for Rivers and Streams, 2000, at http://www2.epa.gov/nutrient-policy-data/ecoregional-nutrient-criteria-documents-rivers-streams.
- U.S. EPA Guidelines for Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses, 1985, at http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/upload/85guidelines.pdf.
- U.S. EPA Nutrient Criteria Technical Guidance Manual for Rivers and Streams, 2000, at http://www2.epa.gov/nutrient-policy-data/criteria-development-guidance-rivers-and-streams.
- U.S. EPA Guiding Principles on an Optional Approach for Developing and Implementing a Numeric Nutrient Criterion that Integrates Causal and Response Parameters, EPA-820-F-13-039, September 2013, at http://www2.epa.gov/sites/production/files/2013-09/documents/guiding-principles.pdf

## IV. Studies, Reports and Articles


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## V. EPA'S APPROVAL DOCUMENTS

- Letter from Tinka Hyde, Director, Water Division, EPA Region 5 to John Linc Stein, Commissioner MPCA, approving Minnesota's new eutrophication and TSS water quality standards for rivers and streams and the Mississippi River pools, January 23, 2015
- Basis for EPA Approval of Minnesota's New or Revised Eutrophication and Total Suspended Solids Criteria in Accordance with Section 303(c) of the Clean Water Act, January 23, 2015
- Memo from Tinka Hyde, Director, Water Division, EPA Region 5, to the file regarding Conformance of Minnesota's Eutrophication Water Quality Standards for Rivers and Streams to EPA's September 2013 Guiding Principles, January 22, 2015

## VI. ENDANGERED SPECIES ACT CONSULTATION

- USFWS. *Minnesota – County Distribution of Federally Threatened, Endangered and Candidate Species*. http://www.fws.gov/midwest/endangered/lists/minnesot-spp.html accessed 6/11/2014.
- Letter from Linda Holst, EPA Region 5 to Peter Fasbender, FWS Region 3, requesting review of EPA's Biological Evaluation and concurrence on EPA's determination that its action is not likely to adversely affect listed aquatic or aquatic-dependent species, January 21, 2015

## VII. TRIBAL CONSULTATION

- Letter from Tinka Hyde, EPA, to 11 tribes in the State of Minnesota, extending an invitation to consult on Minnesota's proposed WQS for eutrophication and Total Suspended Solids (TSS) for rivers and streams in Minnesota, June 3, 2014.
- Summary of consultation outcome from EPA's Tribal Consultation Tracking System. No comments were received from the Tribes by EPA's request date of June 22, 2014. Accordingly, no EPA response to comments was provided.